

## POPULATION AND CONSERVATION OF BLACK-CRESTED GIBBONS (*Hylobates concolor jingdongensis*) IN WULIANG NATURE RESERVE, JINGDONG, YUNNAN

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**Abstract:** Population estimates of black-crested gibbons in Wuliang Nature Reserve, Jingdong, Yunnan, China, with two techniques, average group density-total area and average home range-forest coverage, produced quite similar results. The population was estimated around 115 groups in the Reserve. The paper also discussed the conservation problems of the Reserve. At present, the main threat to the gibbons is habitat fragmentation and population isolation. Thus, it is urgent to prohibit hunting and protect the habitat and forest corridors or habitat bridges.

**Key words:** *Hylobates concolor jingdongensis*; Population; Conservation; Wuliang Natural Reserve

Black-crested gibbon (*Hylobates concolor*) is now confined in Yunnan and Hainan, China; Northern Vietnam, and Western and Northeastern Laos, after white-checked gibbon (*H. leucogeny*) and yellow-checked gibbon (*H. gabriellae*) were separated out (Dao, 1983; Ma *et al.*, 1986; Groves *et al.*, 1990). Among all six subspecies of *H. concolor*, five can be found in China. *Hylobates c. jingdongensis* was described as a new subspecies for its distinguished characteristics of medium size, light golden-yellow pelage and small crown patch in female (Ma *et al.*, 1986). A few studies on its ecology and behaviour were recently reported (Haimoff *et al.*, 1986, 1987a, b; Lan, 1989, 1993; Bleisch *et al.*, 1990, 1991; Jiang *et al.*, 1994a, b). However, data on its population size or group number were highly in controversy, varied from 66 to 300 groups (Lan, 1989; Haimoff *et al.*, 1986; Bleisch *et al.*, 1990; Zhang *et al.*, 1995). In this study, an attempt was made to clarify the population size and conservation status of the subspecies at Wuliang Mountain.

### 1 Study Areas and Methods

Mt. Wuliang is located in the middle of Yunnan, to the east of Mekong. The Wuliang Natural Reserve (100°30' - 100°45'E, 24°17' - 24°42'N) in Jingdong is about 50 km long in the north-south direction and 7 km wide in the west-east direction with a total area of 23 000 hm<sup>2</sup> (Fig.1). The relative height is 2 150 m in the eastern slope and 2 300 m in the west. Black-crested gibbons are found in semi-humid evergreen broadleaved forests and mid-montane humid evergreen broadleaved forests between 2 100 m and 2 600 or 2 700 m in elevation. In addition, three other primate species, *Macaca mulatta*, *M. arctoides* and *Trachypithecus phayrei*, also occur in the Reserve.

Mt. Wuliang is in the subtropical monsoon zone. According to Jingdong Weather Station (Alt. 1 162 m), 78 percent of annual rainfall (1 097 mm) was concentrated in the rain season from June to October. Annual average temperature was 18.3°C (-1.0 to

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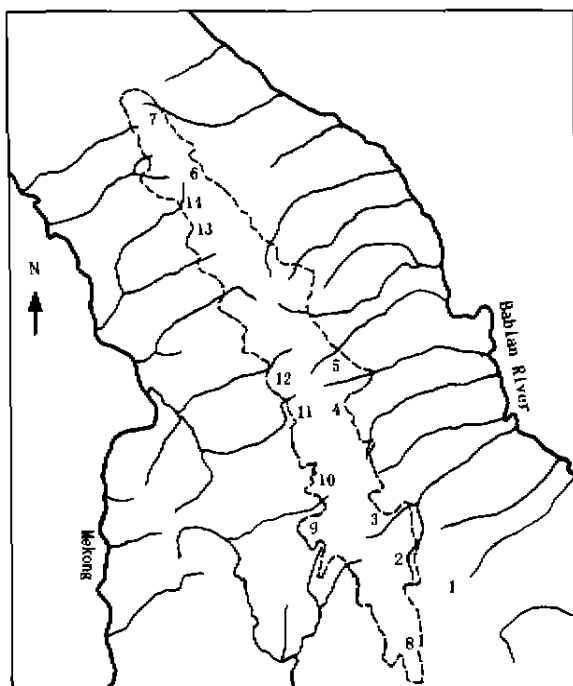


Fig.1 Map of Wuliang Natural Reserve (WNR), Jingdong, showing the study sites numbered from 1-14

1 Xiaobahe; 2 Huangcaolin; 3 Laohuoshan; 4 Huangcaobe;  
5 Luoshuidong; 6 Raomalu; 7 Yanshanchun; 8 Shangchanghe;  
9 Gongping; 10 Mudaohe; 11 Xinchun; 12 Qingmenkou;  
13 Benbu; 14 Wangjiaqinig.

36.3°C), and the lowest temperature ( $-4^{\circ}\text{C}$ ) at Xiaobahe (Alt. 2 240 m) was noted in January 1992.

Though a method of population estimation on gibbons was suggested by listening for the loud duet songs (Brockelman *et al.*, 1987, 1993). Owing to the steep mountainous topography, it is not assured

of a group's song being heard in a single "listening post". And due to average daily duet-occurrence rate was around 50% (Jiang *et al.*, 1987), in the field, we modified the method by choosing 2-5 "listening posts", which were prominent and highest hills with no high trees around, in each survey site, and spending about 6 days in each post. When a group sang a duet, the following information was recorded: beginning time and duration, the direction and estimated distance, and location with a compass, digital stopwatch, data forms and sketch maps. Duet characteristics, especially female's great calls, which were used in identifying groups, were also noted. The survey sites, time and number of listening posts were shown in Fig.1 and Table 1.

Group density ( $D$ ) in a survey site was estimated by  $D = N_1/A_S$ , where  $N_1$  is the number of groups identified in a survey area (when two or more groups sang simultaneously, they were easily distinguished with the knowledge of song organization and direction. While those called at different time, two sites mapped apart more than 500 m were considered occupied by different groups), and  $A_S$  is the area of survey site covered by listening posts. The area size was calculated based on topographical maps (1:50 000). Then the number of gibbon groups ( $N$ ) in the whole Reserve should be  $N = D_A \times S$ , where  $D_A$  is the average group density, and  $S$  is the total area of the Reserve.

Table 1 Survey sites, number of listening posts, groups identified and density in each survey site

Survey site	Survey time	Listening post	Area size/km <sup>2</sup>	Groups identified	Density/gr. · km <sup>-2</sup>
1	Mar. - May and Sep. - Nov., 1990; Nov. 1991 - Jan. 1992; Jan., 1994	5	15	10	0.67
2	Dec. 1997 - Jan. 1998	5	20	8	0.40
3	Apr., 1998	3	3	2	0.67
4	Nov. 1996 - Jan. 1997	5	13	6	0.46
5	Dec., 1996	2	3	1	0.33
6	Mar. - Apr., 1998	3	5.2	3	0.58
7	Nov., 1994	3	3	2	0.67
8	Dec. 1994 - Jan. 1995	3	4.4	3	0.68
9	Apr., 1997	2	2	1	0.50
10	Mar. - Apr., 1997	4	6.2	0	0
11	Nov. - Dec., 1994	2	2.5	1	0.40
12	Dec., 1994	2	1.5	1	0.67
13	Feb. - Mar., 1998	3	4.5	2	0.44
14	Mar., 1998	2	4	2	0.50
Average					0.50

Black-crested gibbons are territorial and arboreal in evergreen broad-leaved forests. Then a second method of population estimation was based on home range and forest coverage,  $N = S_F/S_H$ , where  $S_F$  is the total area of primary evergreen broad-leaved forests, and  $S_H$  is the average size of home ranges of groups.

## 2 Results and Discussion

At Mt. Wuliang, we conducted surveys in 14 sites including 44 listening posts from 1990 to 1998 (some sites were revisited) and 43 groups were identified in all survey sites covered 87 km<sup>2</sup> (Table 1). The average density ( $D_A$ ) is 0.50 groups/km<sup>2</sup> ( $n = 14$ ,  $SD = 0.188$ , range 0 - 0.68 groups/km<sup>2</sup>).

Because all primary forests suitable for gibbons below 2 100 m have become farmland for crops or second forest for grazing livestock and firewood, according to our surveys, all gibbons at Wuliang were confined in the Reserve excepting in Xiaobahe, and our surveys were then concentrated in the Reserve. Though the habitats over 2 600 or 2 700 m were elfin forest and azalea bush which were unsuitable for gibbons to live, our listening posts would cover these areas. The total area of Wuliang Natural Reserve was 230 km<sup>2</sup> (Forestry Survey and Planning Institute of Yunnan, 1989). So the population in Reserve ( $N$ ) were estimated around 0.50 groups/km<sup>2</sup> ( $D_A$ )  $\times$  230 km<sup>2</sup> ( $S$ ) = 115 groups.

After a six-month ecological and behavioral study in Xiaobahe, Jiang *et al.* (1994b) reported that home range of black-crested is about 100 hm<sup>2</sup> ( $S_H$ ). And Bleisch *et al.* (1991) also estimated a larger home range 120 hm<sup>2</sup> at Wuliang. As strictly forest-dwelling animals, black-crested gibbons inhabits in primary broad-leaved forests. The total area of semi-humid and mid-montane humid evergreen broad-leaved forest (habitat) in the Reserve is 11 300 hm<sup>2</sup> (Forestry Survey and Planning Institute of Yunnan, 1989). Therefore, gibbons in the Reserve is estimated about 11 300 hm<sup>2</sup> ( $S_F$ )/100 hm<sup>2</sup> ( $S_H$ ) = 113 groups.

Our estimates based on two techniques demonstrate a quite close result. Concerning home range-

forest coverage estimate, a comment should be made. Gibbons are territorial. Neighboring groups have an overlapping home range along their border, since home range is not an excluding range but territory is. So the population based on home range were probably underestimated on this aspect. However, gibbons did not occupy all the primary forest, Zhang *et al.* (1995) mentioned that fewer small patched forests less than 70 hm<sup>2</sup> supported groups. And on this account, the population on forest coverage tended to be overestimated on the other. The two counteracting facts would offset opposite effect on population estimate.

However, the results were quite different from other estimates (Lan, 1989; Haimoff *et al.*, 1986; Bleisch *et al.*, 1990; Zhang *et al.*, 1995). The highest estimates made by Haimoff *et al.* (1986) were 225 - 250 groups, by Bleisch *et al.* (1990) were 160 - 300 groups, a smaller estimate of 81 groups was made by Zhang *et al.* (1995), and a smaller and varied estimates of 66 - 144 groups was made by Lan (1989). We supposed that a higher average density, a high estimate of total distributing area, and method result in the discrepancy. Haimoff *et al.* (1986) estimated a 300 km<sup>2</sup> over 2 400 m, and Bleisch *et al.* (1990) estimated a 350 km<sup>2</sup> of the Reserve. Even though the actual area of the Reserve is only 230 km<sup>2</sup> (Forestry Survey and Planning Institute of Yunnan, 1989). Meanwhile, they all estimated a higher average density, e.g., 0.82 groups/km<sup>2</sup> based on three-site (Haimoff *et al.*, 1986) and 1.9 groups/km<sup>2</sup> on only one-site (Bleisch *et al.*, 1990).

The smaller estimate made by Zhang *et al.* (1995), was achieved on forest patch size and groups inhabiting. However, the data were only from interviews with local people and reserve officials (see Zhang *et al.*, 1995). And an inappropriate utilization of the methods probably gave a varied result of Lan (1989). ① A survey area size was calculated simply by using listening-post as a center and 1.5 km as a radius. Due to special topographical features at Mt. Wuliang, however, one could not make sure that all songs be heard in radius coverage. ② The determination of

groups was only based on the most groups identified in one day but not on the data in several days. Because daily duet occurrence was only about 50 percent (Jiang *et al.*, 1997), the most groups singing did not mean all groups singing in one day. ③ An underestimation of distribution area (58 – 70 km<sup>2</sup>) was made.

Black-crested gibbons in Mt. Wuliang were found in the primary semi-humid and mid-montane humid evergreen broad-leaved forests. During 1950s – 60s, and sometimes in 70s, a misleading government policy for economic development and population in China, such as iron and steel smelting of all country, economic crops plantation and rapid population increase, had resulted in massive destruction and fragmentation of primary forests. Which is the main reason for the retreat of forest to steep mountain slopes and deep valleys, and the shrinkage and isolation of habitat. The forest line was even pushed up to over 2 200 m so far, though they once ranged below 1 900 m. Gibbons are then confined in large or small isolated patches of forests and are often restricted in different valleys. Zhang *et al.* (1995) noted that there were 63 patches of forest ranged from 14 hm<sup>2</sup> to 2 500 hm<sup>2</sup> and grass-shrub vegetation or farmland isolates these patches, they also mentioned that there were 17 patches less than 70 hm<sup>2</sup>. Fragmented or patched habitats make population isolated in small populations, which means it is difficult or impossible for gibbons disperse and exchange genes among groups. And smaller patches would support fewer groups. Small population size results in both inbreeding and loss of genetic variation, and genetic factor may make isolated population prone to extinct (Frankham, 1998). Because hunting for any in reserve and for protected animals outside has been prohibited, and poaching gibbons has never happened

since 1984, a great threat to black-crested gibbons at Mt. Wuliang is the habitat fragmentation and population isolation.

### 3 Conclusion and Recommendations

Current black-crested gibbons in Wuliang Natural Reserve are around 115 groups. Gibbons are in the list of No.1 national protected animals. Any hunting for protected animals will be committed to severe punishment. And local government of Jingdong County also set up a half year in past and three-year currently as a non-gaming period for all animals. Though a progress has achieved from protecting action (for example, there is no gibbon hunted in last 15 years), public conservation awareness education should be continued.

Black-crested gibbons in the Reserve now inhabit in patched habitats. Population isolation is the principal threat to gibbon's conservation. Fortunately, some of the patches are connected by secondary broad-leaved forest corridors or primary habitat bridges. This makes it possible to exchange genes between groups. So besides conserving primary forest habitat, great attention should be also paid to protect forest corridors and habitat bridges. And setting up artificial forest corridors or habitat bridges for some close patches would be another beneficial attempt.

Black-crested gibbon has been reported to be polygynous, long-term monitoring should be made on habitat, population dynamics, especially individual dispersal, group formation, in order to take suitable conservation measures.

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## 景东无量山自然保护区黑长臂猿的数量与保护

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**摘要:** 无量山地处云南中部, 为黑长臂猿 (*Hyllobates concolor*) 的主要分布区之一。近年来国内外学者虽然对黑长臂猿进行了较多的行为、生态与保护研究, 然而有关该地区黑长臂猿的数量估计却有很大差异 (66~300 群)。如: 蓝道英 (1989) 报道有 66~144 群, Haimoff 等 (1986) 认为有 225~250 群, Bleisch 等 (1990) 也认为有较多的群体, 达 160~300 群之多, 而 Zhang 等 (1995) 认为只有 81 群左右。鉴于这些明显的差异, 笔者基于 90 年代以来对无量山自然保护区黑长臂猿进行的研究, 利用密度法和家域法对其数量进行了估算。两种方法得出相对较一致的结果, 前者约 115

群, 后者约 113 群。本文对他人的结果进行了讨论, 如认为过高的数量估计是由于对面积和平均密度估计过高所致。无量山自建立保护区以来无一起猎杀黑长臂猿的案件发生, 因此“捕杀”已不再是影响黑长臂猿数量因素。然而黑长臂猿现在或多或少地栖息于或大或小的块状原始林中, 群体的岛屿状分布已成为无量山黑长臂猿保护的重要问题之一。因此我们建议保护森林走廊、“栖息地桥”(habitat bridge), 或在较近的片断生境间建立人工栖息地桥应提到黑长臂猿保护日程上来。同时对黑长臂猿栖息地和种群动态进行长期监测, 以便采取更为有效的保护措施。

**关键词:** 黑长臂猿; 数量; 保护; 无量山自然保护区; 生态学

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